


A Python astronomy package for HiPS: Hierarchical Progressive Surveys

Adeel Ahmad¹, Christoph Deil², Thomas Boch³, Brigitta M Sipőcz⁴,
and Axel Donath²

¹ National University of Computer and Emerging Sciences, Islamabad, Pakistan ² Max Planck Institute for Nuclear Physics, Heidelberg, Germany ³ Université de Strasbourg, CNRS, Observatoire astronomique de Strasbourg ⁴ Institute of Astronomy, University of Cambridge, Madingley Road, Cambridge, CB3 0HA, UK

DOI: [00.00000/joss.00000](https://doi.org/10.00000/joss.00000)

Software

- [Review](#) 
- [Repository](#) 
- [Archive](#) 

Submitted: 00 January 0000

Published: 00 January 0000

License

Authors of papers retain copyright and release the work under a Creative Commons Attribution 4.0 International License ([CC-BY](#)).

Summary

HiPS (Hierarchical Progressive Surveys) (Fernique et al. 2015) is built upon the HEALPix framework (Górski et al. 2005) and provides a way to store large astronomical survey sky images and catalog datasets on servers (such as HiPS at CDS (<http://aladin.u-strasbg.fr/hips>), that allows clients to efficiently fetch only the image tiles or catalog parts for a given region of the sky they are interested in.

Currently, there are clients built using HiPS, such as Aladin Desktop (<http://aladin.unistra.fr/AladinDesktop>) and Aladin Lite (<http://aladin.unistra.fr/AladinLite>) but they are written in Java and JavaScript, respectively. There is also ipyaladin (<https://github.com/cds-astro/ipyaladin>), which provides a bridge between Jupyter and Aladin Lite, and enables interactive sky visualization in IPython notebooks.

Scope of the Package

The `hips` package provides flexibility by extending both a high-level and low-level API for novice and advanced users, respectively. It provides the functionality for drawing a sky image from HiPS tiles, transforming HiPS to WCS images, and HEALPix to HiPS—which takes in HEALPix data stored in the “nested” scheme and creates a dictionary object containing HiPS. Additional features include progress bar reporting, asynchronous tile fetching, and support for multiple image formats.

For a more comprehensive introduction to the `hips` package, please see the documentation at (<http://hips.readthedocs.io>) and the source code at (<http://github.com/hips/hips>).

Tile Drawing Algorithm

Projective transformation is applied for projecting HiPS tiles onto the sky image. To achieve this, we first compute the tile corners, which helps us in determining the position where the tile is to be placed. The tiles are further split into four children tiles, which is done to fix the tile distortion issue, and results in a more precise image.

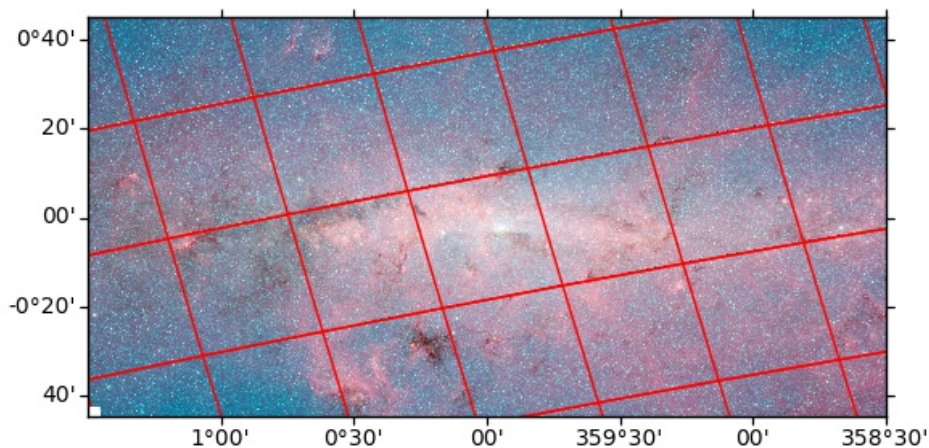


Figure 1: all-sky-image

Example Usage

A sky image from HiPS image tiles can be drawn with the `hips` package, following these steps:

```
from astropy.coordinates import SkyCoord
from hips import WCSGeometry, make_sky_image

# 1. Specify the sky image geometry by creating
# a `WCSGeometry` object.
geometry = WCSGeometry.create(
    skydir=SkyCoord(0, 0, unit='deg', frame='galactic'),
    width=2000, height=1000, fov="3 deg",
    coordsys='galactic', projection='AIT',
)

# 2. Provide a valid HiPS survey ID.
hips_survey = 'CDS/P/DSS2/red'

# 3. Fetch and draw the HiPS data using the
# make_sky_image function.
result = make_sky_image(geometry, hips_survey, 'png')
```

This procedure produces the following image:

Acknowledgements

This project was initiated as part of Google Summer of Code 2017 program (<https://summerofcode.withgoogle.com>) under the Open Astronomy umbrella organization. The authors would like to thank Google for hosting this program. We gratefully acknowledge Astropy (The Astropy Collaboration et al. 2018) for their affiliated packages, such as astropy-healpix (<https://github.com/astropy/astropy-healpix>) and reproject (<https://reproject.readthedocs.io>). We also acknowledge skimage (Walt et al. 2014) for their projective transformation module which is extensively used in this package.

References

- Fernique, P., M. G. Allen, T. Boch, A. Oberto, F.-X. Pineau, D. Durand, C. Bot, et al. 2015. “Hierarchical progressive surveys. Multi-resolution HEALPix data structures for astronomical images, catalogues, and 3-dimensional data cubes” 578 (June): A114. <https://doi.org/10.1051/0004-6361/201526075>.
- Górski, K. M., E. Hivon, A. J. Banday, B. D. Wandelt, F. K. Hansen, M. Reinecke, and M. Bartelmann. 2005. “HEALPix: A Framework for High-Resolution Discretization and Fast Analysis of Data Distributed on the Sphere” 622 (April): 759–71. <https://doi.org/10.1086/427976>.
- The Astropy Collaboration, A. M. Price-Whelan, B. M. Sipőcz, H. M. Günther, P. L. Lim, S. M. Crawford, S. Conseil, et al. 2018. “The Astropy Project: Building an inclusive, open-science project and status of the v2.0 core package.” *ArXiv E-Prints*, January.
- Walt, Stéfan van der, Johannes L. Schönberger, Juan Nunez-Iglesias, François Boulogne, Joshua D. Warner, Neil Yager, Emmanuelle Gouillart, Tony Yu, and the scikit-image contributors. 2014. “Scikit-Image: Image Processing in Python.” *PeerJ* 2 (June): e453. <https://doi.org/10.7717/peerj.453>.